

May, 1910

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AN IMPROVED METHOD OF PREPARING
CATGUT LIGATURES.

A PRELIMINARY COMMUNICATION.

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Good ligatures are an essential in surgery. The ideal ligature should be strong, sterile and soft. It should be capable of preservation for a long period of time without loss of strength or sterility. That numerous methods have been devised for the preservation of catgut is evidence of the lack of satisfaction which they give. There are certain requirements for a proper method of preparation: it should be simple, so that an inexperienced person can carry it out; there should be no handling of the gut after sterilization has begun; the ligature should be placed in a single container at the beginning of the process and should not be removed therefrom until it is needed at the operation; the method should be inexpensive.

These conditions are best fulfilled by the Claudius iodine-alcohol method of catgut sterilization, but this method has certain disadvantages: (1) the Claudius gut does not keep well, but becomes fragile and frangible; (2) the alcohol is not a fat solvent, and sterilization cannot be complete unless a good fat solvent is used to wash the fat from the crevices of the gut; (3) the gut is a little hard for manipulation; (4) the alcohol, containing water, swells the gut a trifle in size. Catgut will readily abstract

water from alcohol. I have been unable to prepare alcohol by ordinary methods of dehydration, such as calcium carbide or anhydrous copper sulphate, so as to render it so free from water that the catgut will not abstract some little moisture from the solution and so cause it to swell. Columbian spirits (deodorized methyl alcohol) is the best of the alcohols for this purpose.

For these reasons, after considerable experimentation in catgut sterilization, I have adopted the following method of preparing catgut:

I. Iodine 3% in acetone, 8 days.

II. Wash in acetone, 4 days.

III. Preserving solution, acetone 85%, Columbian spirits 10%, glycerine 5%. The glycerine should first be dissolved in the alcohol and then added to the acetone, as acetone itself is not a solvent of glycerine.

This method has the following advantages:

The solutions are fat solvents and antiseptics; the iodine is used in greater strength than in Claudius' method and it impregnates the gut so that the ligatures are black and well saturated with iodine when they are placed in the clear acetone solution. The pure acetone abstracts the excess of iodine from the gut, leaving the gut clear and white. The preserving solution of acetone, alcohol and glycerine completes the bleaching and at the same time softens the gut, which is not much softened by the pure acetone. The latter, however, does not harden the gut, but abstracts the water from it and leaves it of the same flexibility as gut that has been preserved in chloroform, as in the well-known commercial process. The addition of the glycerine and alcohol to the acetone in the preserving solution is sufficient in amount to soften the catgut; at the same

time the dehydrating power of the acetone prevents the gut from swelling up, as it does when it is placed in alcohol solution.

Acetone itself is a very strong antiseptic, as is well known from its use in the treatment of inoperable cancer of the uterus. Acetone has also been used in disinfection of the hands by von Herff¹ with good results. He uses equal parts of alcohol and acetone as a hand disinfectant before operations by rubbing the alcohol-acetone mixture into his hands. Bacteriological work with this method of disinfection has been done by Oeri and Phisterer² and by Von Heck³. The acetone bleaches, tans and softens the gut and increases its tensile strength. I made the first experiments with this liquid in the hope of obtaining a substitute for chromic gut, as I was familiar with the hardening action of acetone on tissue in pathological work; but it was found that, instead of hardening the gut, the acetone softened it. At operation, after the gut has dried, it remains soft.

Acetone is antiseptic and comparatively cheap; it abstracts water and absorbs fat from the gut. Water and fat have no place in perfect catgut—fat means imperfect sterilization, for bacteria may exist in a mass of fat untouched by the antiseptics; water swells the gut and softens it, and when the gut dries on the instrument table, it becomes hard, as does all rawhide or leather after having been immersed in a watery solution.

The preserving solution of the mixture of acetone, alcohol and glycerine is one which softens the gut, and at the same time does not swell it in size. It is essential that catgut should be as small as possible for perfect surgery. The gut may be preserved in this solution indefinitely. The finally prepared catgut contains but little iodine, and if it is

desired to have a catgut containing iodine, as does the Claudius gut, it would be well to transfer the gut from the preserving fluid to one of a similar composition with the addition of $\frac{1}{2}\%$ of iodine before it is required for use. Catgut cannot be preserved for more than a month in iodine solutions without lessening the strength, on account of the action of the iodine on the gut.

If the iodine solution is not considered satisfactory for sterilization, the catgut may first be boiled in cumol as in the ordinary cumol process, or in paraffin oil over a sand-bath at a temperature of 212° F. and then run up to 300° F., as advised by Bartlett⁴, before it is placed in the preserving solution. The gut will be softened as well as if it had been put through the iodine and acetone process here described, but it should be left several days in the preserving solution before use, in order to get soft. Personally, I usually boil the gut as a preliminary in paraffin oil, before placing it in the iodine solution to make assurance doubly sure.

The catgut should be cut in the required lengths and wound in coils with three or four ligatures in a coil and held by wrapping the ends four times around. In this way several ligatures can be taken out at once and less handling is required. The ligatures should be placed in wide-topped glass jars with ground glass tops, and should not be taken out of the jar until required at the operation. Jars 7 inches high and 3 inches across are used, and enough for one operation is placed in each jar. The solution may be poured off without disturbing the gut. The jars are previously boiled. No gut is wasted, as the excess not used in operation may be resterilized without loss in strength. If the jars are required outside the hospital, I usually pour off the

solution before packing, in order to lighten the weight. The catgut may be readily picked out of the jar at the time of the operation by means of sterile forceps.

The choice of these solutions was made after extensive investigations in regard to the applicability of various substances and various methods. Carbon tetrachloride was used at first as a solvent of the iodine and as a preservative of the catgut, but the resulting catgut was a trifle hard and the gut deteriorates with time. Chloroform is subject to the same disadvantages, although recommended for this purpose by Burmeister⁵. Acetone is a better antiseptic, a better solvent, and keeps the gut softer. The solution is cheap, costing a little over one dollar per gallon, and it may be used repeatedly. The final cost of the sterilized gut is about a cent a foot.

The choice of the raw gut is of importance, if a good product is desired. The best gut is brown in color; the twists of the gut may be seen, and it is very flexible and strong. White gut, which is bleached by sulphur, seems to get a little harder than the unbleached gut. Gut which is clear and translucent, like violin strings, is not, as a rule, good, for a translucent appearance means that the gelatinous portion of the gut has become firmly coagulated, and if, on pinching the gut between the fingers, a white mark or crack appears it is an evidence that the gut contains a lot of fat and will be hard. The most expensive gut is seldom the best. The best gut I have ever had was rescued in a tangled mass from an old drawer in an instrument shop, where it had lain for years, and it was given to me for nothing.

I have used gut prepared in this way or with carbon tetrachloride for nearly two years with every satisfaction. It is so strong that smaller sizes may

be used for the various ligatures, pedicles, etc. It lasts, size for size, one day longer in the tissues than does cumol gut. It has the advantage of containing no water, so that when it is placed in position it abstracts water from the tissues, which swells the gut slightly and tightens the ligature. At the same time the knot does not slip, as is the tendency in gut preserved in alcohol or watery solutions, for the gut swells slightly around the knot to form a firm mortise joint. This may easily be proved by tying the gut around a soft lead pencil and placing it in water: in a short time it will be found to have tightened on the pencil so as to indent the wood, and yet the knot will be perfectly firm. The tendency of knots tied with gut which has been preserved in aqueous solutions to become untied, is well known, especially if the knot is upon an exposed surface such as the mucous membrane of the vagina.

The gut preserved in the acetone solution retains its elasticity, which is not the case with catgut preserved in alcohol or aqueous solutions. No matter what the method of sterilization, whether by cumol, paraffine or iodine, the acetone-alcohol-glycerine preserving solution offers considerable advantages as a final solution. As before remarked, if it is desired to have the iodine contained in the final solution, it may be added.

This process is the result of the investigations of over fifty methods of preparing catgut, and it is so simple that every surgeon may conveniently prepare his own catgut. The catgut may be stored and kept indefinitely. It is inexpensive as well as simple. It enables smaller sizes of gut to be used with the result that there is less irritation from the size of the foreign body.

Further investigation is in progress in regard to the possibility of using this solution as a preservative of gut in glass tubes.

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